Monitoring upstream movement of lamprey at the Murray barrages in winter 2013 (contract number MD2367)

Introduction

Diadromous fishes migrate between marine and freshwater environments to complete their lifecycle and therefore depend on longitudinal connectivity between marine, estuarine and riverine habitats. There are three forms of diadromy; namely anadromy, catadromy and amphidromy, which differ based upon the environment of adult residence and the environment within which spawning occurs. Pouched lamprey (*Geotria australis*) and short-headed lamprey (*Mordacia mordax*) are the only anadromous fish species native to the Murray-Darling Basin. Their life-history is characterised by a parasitic marine adult life-stage, followed by large-scale upstream spawning migrations into freshwater habitats (McDowall 1996). Juveniles (ammocoetes) are filter feeders, living in mud or silt substrates in freshwater riverine habitats prior to metamorphosis and downstream migration to marine habitats. Whilst there is limited knowledge on Australian lamprey species, evidence from the northern hemisphere suggests that upstream migration of sea lamprey (*Pteromyzon marinus*) is mediated by olfactory cues in river outflows, particularly odours from conspecific juveniles (Bjerselius *et al.* 2000, Vrieze *et al.* 2010). The life-history strategy of lamprey is thus highly dependent upon connectivity between marine and freshwater environments, and the provision of freshwater flows and resulting olfactory migratory cues. As such these species are highly vulnerable to the obstruction of migratory pathways by regulatory structures and diminished freshwater flows to estuaries as a result of water abstraction.

Anecdotal evidence suggests pouched and short-headed lamprey formally migrated upstream to spawn in large numbers in the River Murray (Lintermans 2007), but they are now rare. Additionally, lamprey may migrate over relatively narrow time periods, and when coupled with low abundance, both species may be difficult to detect using standard fish sampling techniques in a large river like the lower Murray. The trapping of fishways on barriers to migration, during the migration season, alleviates some of these issues as individuals are forced to pass upstream through the fishways.

Moderate numbers (n = 40) of adult short-headed lamprey and a single adult pouched lamprey were collected migrating upstream through the Murray Barrage fishways between September and November 2006, during low freshwater discharge (Bice *et al.* 2012). Following cessation of freshwater discharge to the Coorong and closure of fishways in March 2007, no adult lampreys were sampled over the period 2007–2011, despite extensive sampling effort. With the return of considerable freshwater flow and increased connectivity, low numbers (n = 9) of pouched lamprey and a single short-headed lamprey were sampled at the barrage fishways between July and November 2011 (Bice *et al.* 2012). Of the pouched

lamprey sampled, six were implanted with PIT (passive integrated transponder) tags, and one individual was detected migrating through the vertical-slot fishway at Lock and Weir 1 in October 2011.

The objective of the current study was to further investigate the upstream movement of pouched lamprey and short-headed lamprey at the Murray Barrages in winter 2013. Using the barrage fishways as a sampling tool we specifically aim to,

1) Determine the number of pouched lamprey and short-headed lamprey migrating upstream at fishways on Goolwa and Tauwitchere Barrages, and Hunters Creek causeway, over a two-week period in late June 2013
2) Surgically implant lampreys with PIT tags to allow detection on the Murray fishway PIT reader systems should these fish migrate upstream in the lower River Murray

Additionally, knowledge of general fish movement at the Murray Barrages in early-mid winter is poor, with previous investigations predominantly focusing on the spring–early autumn period (Zampatti *et al.* 2010, Bice *et al.* 2012, Zampatti *et al.* 2012). Thus, a secondary aim was to document the general movement of fishes through the barrage fishways over this time period.

Method

Fish were sampled at the entrance of vertical-slot fishways at Tauwitchere Barrage (35°35'09.35''S, 139°00'30.58''E), Goolwa Barrage (35°31'34.44''S, 138°48'31.12''E) and Hunters Creek causeway (35°32'07.08''S, 138°53'07.48''E). The large vertical-slot fishway at Tauwitchere could not be sampled due to SA Water maintenance works. The entrances of the three vertical-slot fishways were sampled using aluminium-framed cage traps, designed to fit into the first cell of each fishway (Tauwitchere small vertical-slot: 1.2 m long x 1.6 m wide x ~1.0 m depth and 0.2 m slot widths, Goolwa large vertical-slot: 2.6 m long x 3.6 m wide x ~3.6 m depth, 0.3 m slot widths, Hunters Creek: 1.6 m long x 1.6 m wide x ~0.6 m depth and 0.1 m slot widths). The trap for the large vertical slot fishways at Goolwa was covered with 6 mm knotless mesh and featured a double cone–shaped entrance configuration (each 0.39 m high x 0.15 m wide) to maximise entry and minimise escapement. Traps for the small vertical-slot fishways at Tauwitchere and Hunters Creek were covered with 3 mm knotless mesh with single cone–shaped entrances (each 0.75 m high x 0.11 m wide).

Trapping was conducted over two weeks from the 24th June to 5th July. Each fishway was sampled overnight for four nights each week, with the large vertical-slot traps deployed and retrieved using mobile cranes. Each individual fish sampled was identified to species and counted, and a random sub-sample of 50 individuals were measured to the nearest mm (total length, TL) to represent the size structure of the population. Any pouched lamprey or short-headed lamprey collected, were implanted with a PIT (Passive Integrated Transponder) tag (Texas Instruments RI-TRP-REHP half-duplex eco-line glass transponders 23.1 mm x 3.85 mm, 0.6 g in air).

a) b)

Figure 1. a) Trap used to sample the Tauwitchere Barrage small vertical-slot fishway and b) the large vertical-slot fishway trap being deployed at Goolwa Barrage.

Results

A total of 6,231 fish were sampled from 14 species over 8 sampling events (Table 1). A total of 12 species were sampled from the Goolwa vertical-slot, 8 species from the Hunters Creek vertical-slot and 7 species from the Tauwitchere small vertical-slot. A total of two adult pouched lamprey (537–580 mm TL) (Figure 1), were sampled from the Goolwa vertical-slot, but no short-headed lamprey were sampled (Table 1).

The catadromous common galaxias and freshwater migrant Australian smelt were the two most abundant species sampled (Table 1). Common galaxias were captured at each fishway but were most abundant at Hunters Creek, whilst Australian smelt were only sampled at Tauwitchere and Goolwa, and were equally abundant at both locations. Based on size and body condition the vast majority of common galaxias sampled were adult fish in spawning or post-spawning condition.

Figure 1. Adult pouched lamprey (*Geotria australis*), sampled from the Goolwa vertical-slot fishway in late June 2013.

Table 1 Summary of species and total number of fish sampled from the entrances of the Tauwitchere large vertical-slot, Tauwitchere small vertical-slot, Goolwa vertical-slot and Hunters Creek vertical-slot from June 24th to 5th July 2013. Species are categorised using estuarine use functional groups from (Elliott *et al.* 2007).

Common name	Scientific Name	Functional group	Tauwitchere small vertical-slot	Goolwa vertical-slot	Hunters Creek vertical-slot	Length range (mm)	Total
Pouched lamprey	*Geotria australis*	Anadromous	0	2	0	537–580	**2**
Short-headed lamprey	*Mordacia mordax*	Anadromous	0	0	0	-	**0**
Congolli	*Pseudaphritis urvillii*	Semi-catadromous	5	74	7	53–272	**86**
Common galaxias	*Galaxias maculatus*	Semi-catadromous	137	789	2001	57–138	**2927**
Golden perch	*Macquaria ambigua ambigua*	Freshwater migrant	0	1	3	117–188	**4**
Flat-headed gudgeon	*Philypnodon grandiceps*	Freshwater migrant	0	9	1	22–61	**10**
Australian smelt	*Retropinna semoni*	Freshwater migrant	1426	1487	0	33–74	**2913**
Common carp	*Cyprinus carpio*	Freshwater straggler	0	2	4	94–191	**6**
Goldfish	*Carrasius auratus*	Freshwater straggler	3	3	23	73–202	**22**
Redfin perch	*Perca fluviatilis*	Freshwater straggler	1	9	14	81–146	**24**
Tamar River goby	*Afurcagobius tamarensis*	Estuarine	3	10	0	27–85	**13**
Lagoon goby	*Tasmanogobius lasti*	Estuarine	1	0	0	37	**1**
Sandy sprat	*Hyperlophus vitattus*	Marine migrant	0	753	0	22–36	**753**
Yellow-eyed mullet	*Aldrichetta forsteri*	Marine migrant	0	207	9	22–76	**216**
		Total	**1576**	**2593**	**2062**		**6231**

Discussion

- Pouched lamprey were sampled in low abundance, whilst short-headed lamprey were absent from the catch. Sampling over a greater temporal period is needed to determine the extent of the migration period for pouched and short-headed lamprey at the Murray barrages.
- Pouched lamprey were implanted with PIT tags and movements through the Murray Fishways may be detected in the future and provide information on upstream migration in the River Murray.
- Substantial numbers of adult common galaxias were collected at all fishways and appeared to be in reproductive condition. Upstream migrating juvenile common galaxias captured during spring/summer at the Murray Barrage fishways have been shown to be derived, in part, from spawning activity in June/July.
- This project has provided significant new information on fish movement at the Murray Barrage fishways during winter. This complements data on fish movement at the Murray Barrages during spring-summer, which was collected from 2006–2012 (Bice *et al*. 2012). Together these data highlight seasonal variation in fish movement and support the year round release of freshwater through the Murray Barrages to facilitate movement.

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